Title: **Evaluating Pinyon Pine and Subalpine Fir Root Growth in a Gravel Bed Growing System**

Principal Investigator: **Robert R. Tripepi**
University of Idaho

Robert R. Tripepi

Date: **December 29, 2005**

Report Series: **Final Report, January through August, 2005**

Grant Agency & Amount: **NAC/ISDA 2004-2, $8,398**

FINAL STATUS OF THE PROJECT

Materials and Methods:

In this study, 3-0 corkbark fir (*Abies lasiocarpa arizonica*) and 4-0 pinyon pine (*Pinus edulis*) seedlings were purchased and transplanted into a gravel bed or field soil for one growing season before transplanting to the field. Details from the first phase of this study (in 2004) were provided in a year-end report to the ISDA last December 2004. Please see that report for detailed information. This current report provides information on the subsequent growth of the pine and fir seedlings during the first year after they were transplanted to the field.

Fifteen plants of the corkbark fir were dug up from the gravel or field beds and transplanted into the field into three blocks (five plants per block) for two months (September and October 2004). Due to poor survival of pinyon pine seedlings in the field and gravel beds, five plants were transplanted into four blocks in the field only in October 2004. The seedlings were irrigated four times from June to August 2005. On August 10, the root-stem collar sections of the seedling trunks were measured twice at 90 degrees from each other to provide the mean stem diameter. The length of the new growth produced by each seedling's main leader was also measured and considered height growth for 2005. In addition, the appearance of corkbark fir seedlings was rated on a scale of 1 to 5 with 1 used for dead plants, 2 for plants with more than half of their needles dead, 3 for plants with about half of their needles dead, 4 for plants with minor amount of dead needles and 5 for plants that lacked any needle damage.

Analysis of variance was used to determine if the transplant month (when appropriate) and growth medium (gravel bed versus field soil) affected mean stem diameter and seedling height growth during the first growing season after the seedlings were transplanted to the field. The overall probability needed to show significant treatment or month effects had to be at or below the 5% level ($P \leq 0.05$) when completing the statistical analyses. Significant differences between treatment means or transplant months were determined by Least Squares Means at the 5% level.

Results:

The corkbark fir and pinyon pine seedlings responded differently to their pre-transplant treatments (gravel bed versus field soil). After one growing season in the field, fir seedlings that were originally in field soil in 2004 had larger stem diameters ($P<0.0024$) and their leaders grew

taller (P<0.0007) than those grown in the gravel bed that year (Table 1). The main leaders on 2004 field-grown seedlings grew about 2.5 cm (about 1 inch) more than those on plants grown in gravel during 2004 (Table 1). Likewise, mean stem diameters were 0.5 to 1 mm larger for field grown seedlings compared to those of gravel-grown seedlings. The month the fir seedlings were transplanted was also significant, with plants transplanted in September having larger stem diameters (P<0.0014) and taller shoot growth (P<0.0022) compared to those transplanted in October, regardless of the growth medium (gravel or soil). Although statistics for the appearance ratings were not completed, fir seedlings grown in the gravel tended to have a poorer appearance than those grown in field soil by August 2005 (Table 1). In fact, three gravel-grown seedlings transplanted in September died, and two gravel-grown seedlings transplanted in October died by August 2005. In contrast, only one field-grown fir seedling died by August 2005, and it was transplanted the previous September.

Table 1. Mean height increase, stem diameter and plant appearance of corkbark fir seedlings in August 2005 after being grown in a gravel bed or field soil and transplanted in September or October 2004.

Month	Treatment	Mean Height Increase* (cm)	Mean Stem Diameter (mm)	Mean Seedling Appearance#
September	Gravel	6.0 b	9.0 b	2.9
	Field	8.5 c	9.6 b	3.9
October	Gravel	4.0 a	7.7 a	3.2
	Field	6.4 b	8.9 b	3.7

* Means followed by different letters within a column indicate significant differences at the 1% level as determined by Least-Square means (n = 15).

Seedling appearance was rated on a scale of 1 to 5: 1 = dead plants, 2 = more than half of the needles dead, 3 = about half of the needles dead, 4 = minor amount of dead needles and 5 = lacked any needle damage.

The pinyon pine seedlings planted in gravel or field soil during 2004 grew similar amounts after one growing season in the field (Table 2). Neither the mean height increases (P>0.8238) nor the mean stem diameters (P>0.5160) were affected by the gravel or soil pre-transplant treatments. All seedlings survived transplanting to the field, regardless of the pre-transplant treatment (gravel bed or field soil). In addition, rating their appearance was unnecessary since all pine seedlings had a moderately healthy appearance.

Table 2. Mean height increase and stem diameter of pinyon pine seedlings by August 2005 after being grown in a gravel bed or field soil and transplanted in October 2004.

Treatment	Mean Height Increase* (cm)	Mean Stem Diameter* (mm)
Gravel	2.9	10.7
Field	3.0	10.4

* Means for plants grown in gravel were based on 20 plants, whereas those for plants grown in field soil were based on 12 plants.

Discussion:

Corkbark fir seedlings that were grown in the gravel bed during the 2004 growing season grew less by the end of the 2005 growing season compared to those plants that were grown in soil in 2004 and then transplanted. These differences (2.5 cm in height and 1 mm in stem diameter) may statistically significant but biologically unimportant. Still, these results are somewhat surprising since the root systems of gravel-grown fir seedlings were larger when transplanted to the field (data presented in the December 2004 report). September transplanted seedlings grew more than October transplanted plants, regardless of the pre-transplant growth medium (gravel or soil). This result may be due to random chance that the September transplanted seedlings were larger than the October transplanted plants. Additional experiments would be needed to verify that transplanting in September improved seedling growth compared to transplanting in October.

Another experimental factor to keep in mind was that the corkbark fir seedlings may have been infected with Fusarium root rot from 2004. You may recall that a number of seedlings were killed by this disease during 2004, and the seedlings that lived were most likely in contact with disease organisms due to their close spacing the gravel bed and field soil. Fusarium root rot may have affected the gravel bed seedlings worse than the soil grown plants after transplanting, thereby causing more gravel-grown plants to die during the 2005 growing season. Overall, the gravel bed may have been detrimental to subsequent growth of corkbark fir plants after transplanting to the field.

The pinyon pine seedlings responded similarly to the pre-transplant treatments. The gravel bed appeared to lack any influence on 2005 field growth of the seedlings compared to field-grown plants (Table 2). Pinyon pines seedlings that survived the first season after being lifted from the seed bed survived the second transplanting regardless of the growth medium (gravel or soil) used in 2004. As expected, even though 2004 seedlings that were transplanted had larger root systems, this advantage failed to result in increased seedling growth after the first growing season. Most likely transplant shock caused all seedlings to grow the same regardless of the size of the root system. Perhaps a few after several more growing seasons in the field the larger root systems may result in increased plant growth.

Significance to the Nursery Industry:

This study demonstrated that two difficult-to-transplant species, corkbark fir and pinyon pine, responded differently to the pre-transplant treatment of being grown for one season in a gravel bed versus field soil. Corkbark fir seedlings grown in gravel during 2004 grew less than by the end of the 2005 growing season than those seedlings planted in field soil during 2004. In addition, more gravel-grown seedlings died during the 2005 growing season than the field grown plants. Although the Fusarium root rot problem from 2004 may have influenced these results, this study shows that each conifer species grown in a gravel bed should be checked to be sure this treatment will not negatively impact subsequent field growth of transplanted seedlings. On the other hand, 2005 stem diameters and shoot heights of pinyon pine seedlings were unaffected by being grown in gravel or soil during 2004, even though gravel-grown seedlings had larger root systems when transplanted. Transplant shock most likely prevented increased plant growth despite more roots being present. Overall, the gravel bed appears to be useful for helping pinyon pine seedlings survive the first year after they are dug from the seed bed, but the gravel bed may be less appropriate for transplanting corkbark fir seedlings due to reduced growth and survival of gravel-grown plants during the following year.